Chapter 3

# Weevil Borers in Tropical Fruit Crops: Importance, Biology and Management

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**Abstract**

Weevils are an economically important group of Coleopteran insects of the family Curculionidae. This is the largest insect family in the superfamily Curculionoidea. They may be found almost everywhere and more than 3000 species in near of 500 genera occur in North America. Most of them are plant feeders and others are key pests. These weevils use the snout to feed on plant tissues and notch egg-laying sites on it. Adults drill holes and feed in seeds, fruits and other reproductive parts of the plants. Some of the most notable examples of weevils include *Conotrachelus* spp. on avocado and guava, *Optatus palmaris* on anonaceous fruits, *Heilipus lauri* on avocado, *Hypothenemus hampei* on coffee berry and others. The presence of some of these species requires establishing measures of restriction when the product is for exportation. Management practices and postharvest treatments are required to ensure that the fruits will be free of larvae. In this chapter the main species of weevils in the most important tropical fruit are included, such as avocado, coffee, guava and anonas fruits. Weevils of economic and quarantine importance are considered.

**Keywords:** weevils, tropical fruit, management, importance

## 1. Introduction

The members of the Curculionidae family are called weevils, since most of them have more or less prolonged head anteriorly as a peak or nose; this term is less appropriate (and rarely used) for Platypodinae and Scolytinae, because there is only little development of the peak in these two subfamilies.

Borers and weevils, including bark and ambrosia, are the members of this family most commonly found. This family shows considerable variation in size and shape. The peak is well developed in most species, with capitate antennae appearing in the middle of the peak. In Scolytinae, Platypodinae and some Cossoninae, there is no peak. The Curculionodae species present a complete metamorphosis (egg, larva, pupa and adult); the family has great economic importance by the number of pest species.

The male external genitalia comes in two types: Ortocera or Gonatocera—in the first one, plates of the aedeagus are known as tecto and the pedon; in the second one, only it remains the pedon; and in some families, there is a clear reduction of the tecto. The antennae are presented in two types—straight or elbowed—in addition some appear to be geniculate [1].

Almost all weevils are phytophagous and among these, there are many important agricultural and forest pests. Almost any part of the plant can be attacked, from the roots to the aerial parts; usually the larvae feed within plant tissues and adults make holes in the fruits, nuts and other parts [2], except for myrmecophilous, saprophagous and predatory species [3].

As mentioned most of them are herbivorous and economically important pest because they affect crops by reducing yields or affect stored products. They can actually cause large losses since the female makes holes somewhere in the plant, either branches or fruits to oviposit. In other cases, females lay eggs on the surface and when the larvae emerge, they pierce the fruit or branches, feeding on plants tissues; in the case of ambrosial weevils, they feed on fungi, which are cultivated within the plant, causing direct and indirect damages.

We considered the main species of weevils in the most important tropical fruits, for example, avocado, coffee, guava and anonas fruits. Weevils of economic and quarantine importance are considered. We talk about topics like biology, importance, damages and suggestions to their control.

## 2. Big avocado seed weevil, *Heilipus lauri* Boheman

### 2.1. Description

The egg of *H. lauri* is oval; its surface is finely reticulate with pentagonal forms. It is 1.40 ± 0.06 mm long and 0.87 ± 0.03 mm wide. At the moment of the oviposition, the chorion is bright white; during its embrionary development, its color changes from clear brown to dark brown. The forth instar larvae reach 24.21 ± 1.49 mm length. The body is robust, curved with color opaque white; the measurement of the head is 1.87 ± 0.06 mm wide and color clear brown and it is not retracted in the prothoracic segment. The pupae are the exarate type with color creamed white and 16.97 ± 1.25 mm in length. Adult (**Figure 1**) with opaque integument is black reddish in most of the surface of the body, except legs which are reddish. The length of the body, excluding the head (rostrum), is 14.77 ± 0.87 mm in the case of females and 13.78 ± 0.76 mm in males. The head (rostru m) reaches 7.29 ± 0.67 mm in the females and 5.32 ± 0.28 mm in the males. It is curved in the females and slightly more thick than in the males; in malesthe rostrum is short and straight. A distinctive characteristic of this species is the pair of

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irregular enlarged spots, formed by copactation of small opaque orange oval scales. The first pair is the biggest and it is located 2/5 at the base of the elytra and the second one, 1/5 of the apice, located almost over the periapical callus [4].


**Figure 1.** Male of *Heilipus lauri,* big seed borer of avocado.

### 2.2. Distribution

*Heilipus lauri* is a species with broad altitudinal adaptation, from 594 to 1900 over sea level. Its distribution includes Mexico [5, 6], Honduras (D. Cave 2013, *in litt*.) and Colombia [4]. Its presence in Mexico includes the states of Morelos, State of Mexico, Puebla, Hidalgo, Oaxaca, Puebla and Veracruz [2, 5, 7].

### 2.3. Host plants and biology

According to [8] in the State of Mexico, *H. Lauri* causes damage in avocado Hass, Fuerte and Colin V-33. Medina [9] documented that in the Morelos state. *H. lauri* has a preference for fruits of criollo avocado, *P. americana* var. drymifolia and Choquette cultivars Hass and Fuerte. Recently [7] added to *P. americana* var. *american* as a new host. Castañeda Vildozola [5] reported the presence of *H. lauri* in fruits of *Persea schiedeana* Nees in Huatusco and Zongolica, Veracruz. The information from these authors represents the first report of *H. lauri* damaging a different fruit of that of avocado species. The egg incubation period is 10.87 ± 0.45. In Ixtapan de la Sal Mexico State, females ovipositing have been recorded from March to September. This behavior is closely linked to the phenology of avocado in the region. Larva: It is found in a cotyledon where it feeds and develops its larval stage; its life cycle completes in 48.51 ± 2.30 days. A typical feature of *H. lauri* is that it develops a single larva per fruit and even two; these do not destroy the seeds, when they are used. In Ixtapan de la Sal, the presence of larvae of *H. lauri* occurred from April to August. Pupa: Close to pupation, the larvae form a pupation chamber inside one cotyledon, lodge and stand still to be transformed into pupa. The pupa occurs from late August to September. Adult: The longevity of adults in laboratory conditions was 309.55 ± 86.72 days. Adults have diurnal habits; their presence is very noticeable during fruiting avocado period from 09:00 to 19:00 h. Field emergence of new adults occurred from September to April 2005. *H. lauri* biology is closely linked with the phenology of avocado in

Ixtapan de la Sal. The availability of food throughout the year (fruits and foliage), avocado genetic diversity and environmental conditions play a role in favor of the presence of this insect [10].

### 2.4. Damage

Females drill and lay eggs directly in growing fruits (**Figure 2**) causing its injury inside; once the larvae emerge, they feed through the pulp to reach the seed where it completes its life cycle. When heavy infestations are recorded and no management is used, infestations of larvae can damage up to 67% of the fruits; in orchards with management of the pest, it has been quantified losses of 3% [9].


**Figure 2.** Damages in fruits by *Heilipus lauri*, big seed borer avocado.

## 3. Small avocado seed weevil, *Conotrachelus perseae*

### 3.1. Description

Egg: This is elliptical; the chorion is semitransparent when oviposited and acquires a graying color when the larva is next to emerging; it is less than 1 mm in length [1]. Larva is yellowish white and dark cephalic capsule. Prothorax has a suture open V-shaped and three ventral setae. The mesothorax and metathorax present two dorsal lobes; these segments in the posteroventral region have a dorsal setae. All abdominal segments, except the last one, have three dorsal lobes and three ventral setae. Well-developed larvae reach a length of 6 mm [11, 12]. In pupa, the prothorax has five pairs of lateral setae and three pairs forming two rows on the

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sides. The mesothorax has two pairs of setae located within a lobe and in the middle part is the other rounded lobe. Abdominal segments are characterized by two pairs of setae in the ventral part of each segment; the eighth and ninth segments present a pair of lateral setae [12]. Adults (**Figure 3**) are dark brown; prothorax, in dorsal view, is strongly constrained in the apical portion [3, 13–15]. Humeral region of the elytra of *C. perseae* is wider than the base of prothorax.


**Figure 3.** *Conotrachelus perseae*, small avocado seed weevil.

### 3.2. Distribution

*Conotrachelus perseae* was first described from specimens collected in Guatemala [14]. This pest has been reported in Honduras, Costa Rica and Mexico [15, 16]. In Mexico, its presence has been documented in Chiapas Guanajuato, Michoacan, Puebla Hidalgo, State of Mexico and Veracruz [17, 18]. *C. perseae* adults are nocturnal and stay hidden during the day. Damaged fruits show small superficial holes. The larvae feed in seeds and the pupae are formed out of the fruit, commonly on the floor.

### 3.3. Host plants and biology

Both weevils have been collected in "Criollo" avocados, Hass and Fuerte [3, 19]. Castañeda Vildozola [17] added *Persea floccosa* as a new host of *C. perseae* in Mexico. The egg incubation period occurs between 4 and 13 days after oviposition. The duration of the larval stage of *C. perseae* is 15 to 30 days. Once the larva has completed its development inside the fruit, they migrate to ground where pupation occurs, reaching a depth of 3 to 11 cm. Pupal stage lasts 35.5 days. The longevity of adults is 111 days for male and 140 days for females. Adults are nocturnal; during the day they remained hidden in the stems and leave bent leaves and inflorescences [2, 12, 19]. In Tacambaro, Michoacan [8, 20], he concluded that the presence of the different stages of development occurs as follows: egg from late January to late

March, larvae from February to April, pupa from March to early May and adult from July to mid-September.

### 3.4. Damage

Adults damage fruits when they reach 2 cm diameter; fruits are perforated during oviposition. The larvae feed the pulp of the seed. Once concluded the larval stage, the fruits fall to the ground because of the destruction of the seed [12] causing loss of 85% if control measures are not applied.

## 4. Avocado branch weevil borer, *Copturus aguacatae*

### 4.1. Description

The egg is oval in shape, measuring 0.5 mm long and 0.3 mm wide; early oviposited eggs are translucent and then change to white. Larva. A well-developed larva reaches 12 mm in length and is milky white. The head capsule is retracted in the first thoracic segment. The prothorax is ossified in its highest zone and covered with small scales and laterally presents an oval spiracle. In the predorse and postdorse of the mesothorax and metathorax are present two dorsal folds. On the first abdominal segment, there are three dorsal folds and the segments II to VII with four folds. VIII to IX segments have no dorsal folds. All abdominal segments have setae varying in number, size and arrangement. The pupa is exarata and measures 5–8 mm long and 2–2.5 mm wide [9]. They are creamy white. The rostrum reaches the metathoracic coxae. Adults are romboidal shaped, measuring 3.77–5.0 mm long and 2.0–2.5 mm wide [21]. They are black to reddish black with small white scales, red, orange, or black. The females are bigger than the males. They have an almost triangular prosternal ridge between coxae.

### 4.2. Distribution

The presence of the avocado branch borer has been registered in the states of Morelos, Michoacan, Puebla, State of Mexico, Queretaro, Guerrero, Nayarit and Oaxaca [9, 22, 23].

### 4.3. Host plants and biology

The avocado is reported as only host [9, 23]. Medina [9] reported that in the state of Morelos, *C. aguacatae* cycle lasts 200 days; egg has an incubation period of 10–12 days; the larval state lasts 120 days with five instars, each lasting 20–24 days; pupae last 15 days; and the adult has a life span of 45 days. Leos-Rodríguez [24] concluded that the biological cycle of *C. aguacatae* in Uruapan, Michoacan, had a duration of 169–192 days, the incubation period of the egg was 10–12 days, the larval stage was completed in 108–117 days and the pupa in 17–19 days and adult longevity was 5 days. The adults are diurnals; often they walk on branches with quick movements. In Ziracuaretiro, Michoacan, the presence of adults occurred from June to November; the egg state was recorded from September to June. The larvae were recorded in the months of September to June and pupae were recorded in May and July [23].

http://dx.doi.org/10.5772/66635

### 4.4. Damage

Damage is caused by larvae. The branches affected are those with greater exposure to the sun. Flowers and fruits are not damaged by the larva. The branches are affected from the epidermis to the core; damage is observed on large surface areas covered with lumps of crystallized wise. A consequence of damage, branches in production can be disrupted by the weight of the fruit [23].

## 5. Control strategies for *Heilipus lauri, Conotrachelus perseae, C. aguacatae* and *Copturus aguacatae* in Mexico

The importance of these species in Mexico is that they are classified as quarantine importance insects; fruit movement to avocado regions free of this pest is not allowed. This restriction is also valid for international market, specifically in the United States where the marketing of Mexican avocados were prevented since 1914 until November 1997 [25, 26].

Mexican Official Standard NOM-066-FITO-2002 has defined areas as free of seed borers and phytosanitary areas under control. The first step to prevent the spread of weevils to free areas of the pest is that the government of Mexico through the SAGARPA considers more rigorous sampling at points of entry and exit of agricultural products and makes strong awareness campaigns for people to be careful with fruit that moves from one place to another [27]. It is important to continue the implementation of studies to learn more about these insects of which is much talk, but little is known.

### 5.1. Control methods

#### *5.1.1. Cultural control*

It is advisable to remove the fruits with signs of damage by seed borers and prune the branches affected by this pest. All these materials should be burned for the control of eggs and immature stages; even though it is a late form of control, it is certain that it will be effective for the next cycle of the crop; less damage will be present, if control is supplemented by other measures. For *Conotrachelus perseae* it is recommended to track the ground because larvae next to pupation leave the fruit and stay on the floor to form cell pupation; this practice exposes larvae to desiccation or predators as birds.

#### *5.1.2. Chemical control*

In Mexico, some products are approved to be used in avocado orchards; an example is permethrin at doses of 200–300 cc in 100 L of water. The organophosphate insecticides, such as methyl parathion and malathion, are recommended for avocado pest control [9]. In the case of *H. lauri* and *Copturus aguacatae*, for their diurnal habits, the recommendation is to apply at early hours in the morning; for *Conotrachelus perseae* it should ideally apply at night as these insects are active from start of the night until dawn [19].

*5.1.3. Legal control*

It requires a local legal framework (in the stated affected by the presence of weevils) to attend a plant management program in backyard orchards which are reservoirs of this group of insects. Integrated management campaigns, which according to the NOM-066-FITO-2002 standard is to establish requirements and specifications for the phytosanitary handling and movement of plants and fruits of avocado. This standard indicates that avocado weevils are considered as an obstacle to export fruits; in consequence this is a limitation for exporting Mexican avocados to the US market. This situation remains latent, as producers of avocado in California and Florida are still dissatisfied with market opening arguing great risk of introducing weevils and other insects which may affect avocado orchards in these US states [26].

## 6. Guava weevil, *Conotrachelus dimidiatus*

### 6.1. Description

According to [28] adult presents elytra with discontinuous ridges and is less developed than *C. psidii*; the mesosterna is concave between mean coxae where few shallow spots occur; the metasternum has points more or less deep and evenly distributed and the crest is continuous in the range five; unlike *C. psidii* C, *C. dimidiatus* presents bifid nails.

### 6.2. Distribution

In Mexico, it was reported by misidentification of the species *C. psidii* [29]; years later [30] reported that the species belonged to *C. dimidiatus*, which is distributed in Mexico, Guatemala and Honduras [31]. This species causes major damages to the crop and is widely distributed in the producing areas of Mexico.

### 6.3. Host plants and biology

In Mexico, two species of *Conotrachelus* damaging guava are reported; however, *C. dimidiatus* is the species that causes the greatest damage [32]. The insect life span is one year; the egg incubation period is 6–9 days; the larva goes through a period of diapause for several months; however, on average it takes 51 days, the pupae 30 days and adult 75 days.

### 6.4. Damage

Once adults emerge from the soil, they fly to guava trees to feed; females lay eggs on the middle of developing fruits (**Figure 4**); after hatching, the larvae penetrate into the fruit to feed. Damaged fruits develop kidney shaped, mature and fall prematurely (**Figure 5**). In Calvillo, Aguascalientes, Mexico, the infestation of fruits averages 37.4%, which is higher in the lower portion of the tree and during the rainy season, the fruits are more susceptible when they are young, developing two to four cm of polar diameter [33]. The larvae feed the pulp, causing destruction and blackening of this and seeds (**Figure 6**). If control practices are not done or treatments are performed at inopportune seasons, damages could be extreme [22].

http://dx.doi.org/10.5772/66635

**Figure 4.** Damages in fruits by adults of *Conotrachelus dimidiatus*.

**Figure 5.** Damaged fruits by *Conotrachelus dimidiatus*.

**Figure 6.** Damaged fruits by larvae of *Conotrachelus dimidiatus*. Note the blackening of the pulp.

### 6.5. Control methods

In the orchards, control is based considering the behavior and biology of the insect, according [22, 33] to the presence of adults they have relationship with the rainy season, which are the ones to initiate the damage and infestation of fruit. Based on sampling, using a network under the tree before the start of rainy season, the detection of an adult/tree and observation of fruits with oviposition, applications of chemical insecticides, repellents and entomopathogenic are needed. Local tests to evaluate the effectiveness of these products are recommended; control is complemented with the destruction of damaged fruit that remains attached to the tree. When the fruits are harvested to export to the United States, they are treated by irradiation to eliminate, among other pests, guava weevil. According to [33, 34], the use of chemical attractant traps can be used to sample and detect weevil populations. Biological control is still not a practice used against weevil; we have found parasitoids, predators of larvae and prepupae; however, it is an activity that should be investigated and expand their knowledge in the future. Similarly, the identification of chemical attractants and pheromones as an alternative control should be integrated into weevil control.

## 7. Coffee berry borer, *Hypothenemus hampei*

### 7.1. Description

According to the description [35], the egg is bright white at the beginning to become opaque later. Chorion surface is smooth, measured 0.64 mm long and 0.32 mm in diameter. The larva is white, wormlike and fully developed measuring 1.39 mm in length and has well-developed sclerotic jaws. The pupa is white at the beginning and becomes coffee later; sexual dimorphism exists in relation to size, which is also manifested in adulthood; the female pupa measures 1.18 mm long and 0.88 mm male. The adult is 0.5–0.8 mm in length.

http://dx.doi.org/10.5772/66635

### 7.2. Distribution

The coffee berry borer (CBB) is native to equatorial Africa and is currently distributed virtually in every country where coffee is grown [36].

### 7.3. Biology

These insects remain within the fruit much of its life cycle, as egg, larva, pupa and adult stages. The female only leaves to infest new fruit; males remain inside until death making difficult its control [37].

### 7.4. Damage

In some countries the infestation levels can be up to 90%; in Nayarit, Mexico, it has been recorded up to 70% in orchards with minimum crop management. The female drills close to physiologically mature fruits; inside it lays eggs and, when the larvae emerge, feeds the endosperm of the seed; and it decreases quality and yield.

### 7.5. Control methods

Due to the wide distribution and importance of the coffee berry borer and the conditions for growing coffee, its control requires a large integrated approach, in which the use of traps with attractants and the application of entomopathogenic microorganisms and parasitoids predominate over the application of insecticide chemicals. The integrated management of the coffee berry borer starts with sampling and determining the economic threshold of action, in Colombia, for example, [38] recommends a maximum fruit infestation of 2% to initiate control activities. The use baited traps for catching and sampling of coffee berry borer is a widespread technique and contributes to both detection and reducing pest significantly. To this respect [39] recommend installation of 22 traps each 10 ha with a mixture of ethanol-methanol 1:3 (v/v) with 1% benzoic acid, as an optimal, effective and inexpensive amount for integrated management of the CBB. The widespread use of *Beauveria bassiana* against adults of the CBB and the presence of native entomopathogenic fungi must be taken into account because of the results obtained [20] to observe inhibitory effects of the development of this fungus by applying insecticides such as chlorpyrifos, endosulfan and disulfoton. The use and establishment of parasitoids with classical biological control method have been successful in all places where it has been implemented; the parasitoid *Cephalonomia stephanoderis* is widely distributed and it has remained despite applications of chemical insecticides. In some cases this can control 94.8% of the CBB [40].

## 8. Annonaceae weevil, *Optatus palmaris*

### 8.1. Description

According to [41], the adult presents strops separated at the apex by a visible keel, middle lobe of the pronotum with a short tubercle on each side and elytra with points of inter-stretch

marks forming transverse grooves; the forelimbs are longer in males, with more dilated and bristly shanks (tarsus). The length of prothorax + elytra is 6.5–9.3 mm in males and 6.8–8.6 mm in females. It has a wide body, is rhomboid, has blackening layer, and is covered with fine decumbent scales. The head and face are 7.6–9.0 mm long in males and 7.5–8.2 mm in females and 1.4–1.8 mm wide in male and 1.5–1.7 mm in females, sometimes as long as the prothorax length, inserted at the top of the head in lateral view and slightly curved, reducing its size toward the apex, with lateral grooves in the middle basal; the face (rostrum) of the female is less sculpted than in the male, almost cylindrical, with scores and smaller scale and more limited compared to the male. Middle inserting antennae are 0.53–0.55 in males and 0.52–0.56 mm in females. Antennae with scapum are 0.34–0.38 and 0.33–0.35 times the length of the head (rostrum) or peak in males and females, respectively.

Thorax: Prothorax sometimes is wider than longer. Pronotum is moderately convex; medium lobe is pronounced, subtruncate, slotted dorsally and moderately emarginate and with a short tubercle on each side. The lateral region of prothorax is furrowed near the tip; the lower anterior margin is sub-straight. Mesepimeron is not prominent in the anterior region but visible in dorsal view. Scutellum (1.4–2.3 mm in male) sometimes is as wide as long with the anterior margin sub-straight and acute apex. Elytra (1.8–2.0 in males, females 2.0–2.2) is longer than the prothorax, (1.1 mm male) sometimes as long as broad; subtriangular; humerus is rounded and is present dorsolaterally; pre-apical slang developed; find superficial stretch marks. Description of larval and egg is missing, being a pest of recent detection and increasing their damage, are required to perform morphological studies and evaluate alternative control.

### 8.2. Distribution

*Optatus palmaris* spread in Mexico, Guatemala, Costa Rica, Peru, Brazil, Bolivia, Colombia, Paraguay, French Guyana, Ecuador, Honduras, Panama, Venezuela, Trinidad and Tobago and Argentina [42, 43]. In México it is present in the states of Michoacan, Guanajuato, Oaxaca and Nayarit [31, 34].

### 8.3. Host plants and biology

The genus *Optatus* is closely related to fruits of Annona [43]. *O. palmaris* in Mexico is associated to *A. diversifolia*, *A. cherimola* and *A. muricata* [28, 34]. According to [34], the egg incubation time is 5.36 ± 0.69 days with variation of 4 to 8 days at 24°C and relative humidity of 72 ± 2%. The larva lasts 73.5 ± 3 days, with an interval of 54 to 93 at 24.9°C and relative humidity of 81.3%; its pupal period lasts 25.1 ± 1.6 days in the range of 17–41 at 25°C and relative humidity 81.5 ± 0.12%; the adult lives 34–150 days, with an average of 112 ± 23.51 at 26.76 ± 0.03°C and relative humidity of 67 ± 0.2%. *O. palmaris* biological cycle lasts on average 216 ± 28.7 days, with an interval of 109–292 days.

Adults take refuge in the foliage of their host and feed on vegetative buds, flowers and fruits. They choose fruits close to physiological maturity where they form groups to feed, lay eggs and copulate. It is possible that the adult releases an aggregation pheromone; this may be influenced by volatile compounds of fruits during its developing stage, maybe because in

http://dx.doi.org/10.5772/66635

young vegetative buds and flowers, they appear very sporadic and solitary. The adults of *O. palmaris* make circular holes in the fruits that later become necrotics; they can create a sort of chamber where the female lays eggs. The female feeds and lays eggs; the male is dedicated exclusively to copulate and scarcely takes food during copulation time. After this period, adult migrates to the top of the tree for resting and feeds on young vegetative buds and flower buds; after 24 h it looks for females and continues copulating. These activities are done 15 h per day.

### 8.4. Damage

*Optatus palmaris* causes damage in chirimoya (*Annona cherimola*) [41, 42]; it has also been found in soursop, *Annona muricata* L. and ilama (*Annona diversifolia* L.). The larvae feed on the pulp and seeds of the fruit; in the final of the larval stage, it leaves the fruit and pupae in the soil [42]. Adults make holes in the fruits of soursop and chirimoya when they are feeding (**Figure 7**) or lay eggs (**Figure 8**); when there are no developed fruits, they feed on the petals and pedicel of small fruit, causing its fall. Damage of the species of the genus *Optatus* in *A. cherimola* corresponds to a pattern of drawings, similar to the letters "C" or "O," which is a group of holes caused by adults when they feed; in places where the larvae feed, first necroses and slight watery discharge are observed; feeding causes a small hole deepens to seed; when moves from the fruit, it leaves a hole of 2–3 mm in diameter [42]. In soursop, *O. palmaris* adults can damage 38% of the total area of the fruit and it is possible to find an average of six larvae per fruit. The fruits most affected are those close to the harvest [34].

**Figure 7.** Damaged fruits of soursop by *Optatus palmaris*.

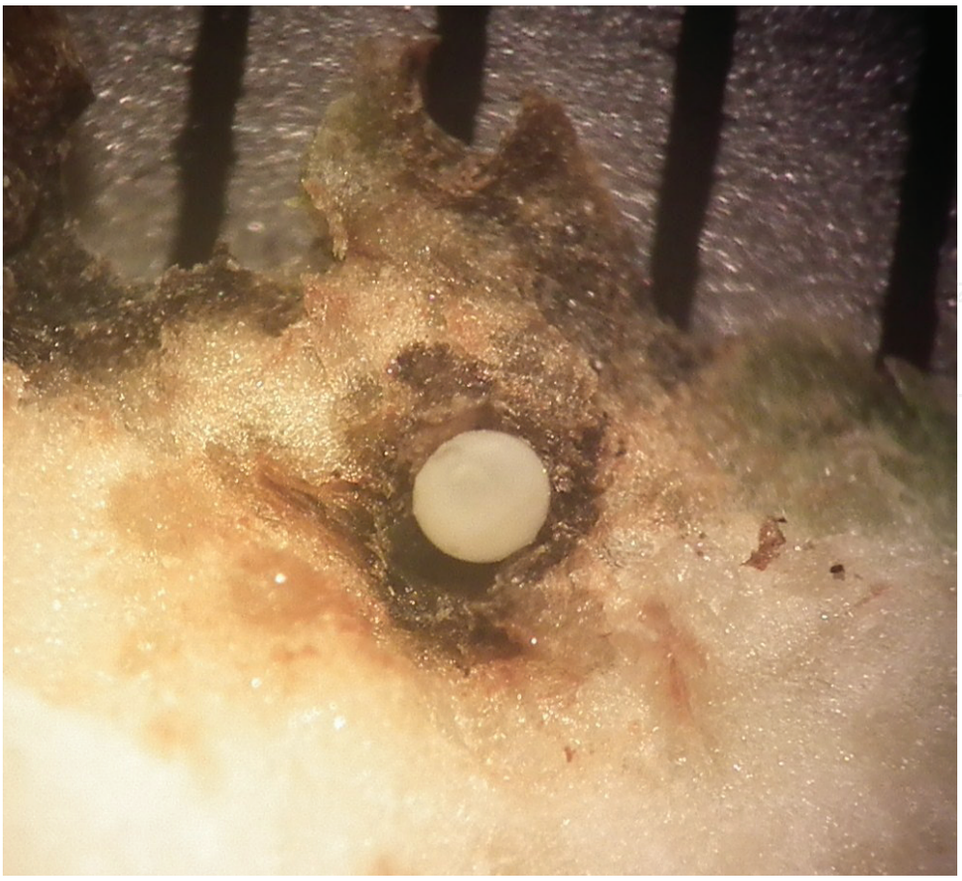

**Figure 8.** Egg of *Optatus palmaris*. Space between the black lines is a millimeter.

### 8.5. Control

Because of recent detection as Annonaceae pest, considering aspects of its biology and habits, control methods have not been evaluated. It has been observed that it is more frequently damaging in the producing annonaceae areas in Mexico; it is necessary to consider this pest as main insect pest of these crops and evaluate different methods of control and search of natural enemies: parasites, predators and entomopathogenic fungi. Based on their mating and feeding habits recorded by [34, 42], the use of volatile compounds appears to be a good alternative management; however, further studies are required in this regard.

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## References

[1] Leitao B. M. L. Phylogenetic systematic of the tribu Neotropical Optatini Champion, 1907 (Coleoptera, Curculionidae, Baridinae). Instituto Nacional de Pesquisas da Amazonia. Universidade Federal do Amazonas. Programa Integrado de Pos-Graduacao em Biologia Tropical e Recursos Naturais, Manaus, Amazonas. 2007.

[2] Domínguez J. V. Morphology of small borer seed *Conotrachelus perseae* Barber. Campus Montecillo, Postgrado en Fitosanidad, Entomología y Acarología, Colegio de Posgraduados, Montecillo, Texcoco, Estado de México. 2006.

[3] Muñiz V. R. Study morphological of two species of *Conotrachelus,* that are pests of the avocado (Persea gratísima Gaertn) in Mexico. Rev. Soc. Mex. Hist. Nat. 1970. 31:289–337.

[4] Castañeda Vildozola A. Bioecology of the big borer seed of the avocado *Hilipus lauri* Boheman (Coleoptera: Curculionidae) in the region Central de Mexico. Colegio de Posgraduados en Ciencias Agrícolas, Montecillo, Texcoco, Edo. De México. 2008.

[5] Castañeda Vildozola A., Equihua-Martínez A. and Peña J. E. Avocado weevils of the genus *Heilipus*, pp. 35–47. In: Peña J. E. (ed.), Potential Invasive Pests of Agricultural Crops. CAB International, London, U.K. 2013. 464 pp.

[6] García A. P. *Hilipus lauri* Boheman a borer of the avocado seed in Mexico. Escuela Nacional de Agricultura, Chapingo, México. 1962.

[7] Palacios-Torres R. E., Castañeda Vildozola A., Sánchez-Pale J. R., Franco Mora O. and Vargas-Rojas L. Interaction of Two Avocado Fruit Insect Borers in the Same Agroecological Area in Mexico. Pan-Pacific Entomol. 2016. 92(2):100–103.

[8] Salgado-Siclán M. L., Bautista-Martínez N. The big borer seed of the avocado in Ixtapan of the salt, Mexico State. In Memoria. Fundación Salvador Sánchez Colín CICTAMEX, S.C. Coatepec Harinas, Estado de México. 1993. pp. 225–231.

[9] Medina Q. F. Incidence of the big borer seed of the avocado *Heilipus lauri* Boheman (Coleoptera: Curculionidae) in Tepoztlan, Morelos. Facultad de Ciencias Agropecuarias. Universidad Autónoma de Morelos. 2005.

[10] Castañeda Vildozola A., *Persea schiedeana* (Lauraceae), new host of *Heilipus lauri* Boheman (Coleoptera: Curculionidae) in Veracruz, Mexico. Neotrop. Entomol. 2009. 39:914–915.

[11] Díaz C. F. Biology and control of the small borer seed (Conotrachelus perseae) Barber in the region of Toliman, Queretaro. Escuela Nacional de Agricultura. Chapingo, México. 1972.

[12] Llanderal De la Peña L. L., Ortega H. A. Biology, habits and identification of the small borer seed of the avocado (*Conotrachelus perseae Barber*) in Ziracuaretiro, Michoacán. Facultad de Agrobiología "Presidente Juárez". Universidad Michoacana de San Nicolás de Hidalgo, Uruapan, Michoacán. 1990.

[13] Barber H. S. Avocado Weevils. Proc. Entomol. Soc. Wash. 1919. 21:53–61.

[14] Barber, H. S. Two New *Conotrachelus* from Tropical Fruits. (Coleoptera: Curculionidae). Proc. Entomol. Soc. Wash. 1923. 14:181–183.

[15] Whitehead D. R. Recognition Characters and Distribution Records for Species of *Conotrachelus* (*Coleoptera: Curculionidae*) that Damage Avocado Fruits in Mexico and Central America. Proc. Entomol. Soc. Wash. 1979. 81:105–107.

[16] González-Herrera A. Arthropods associated with the cultivation of the avocado (*Persea americana* Mill.) in Costa Rica. Proceedings of the World Avocado Congress V. Malaga, Spain. 2003. pp. 449–454.

[17] Castañeda Vildozola Á., Franco-Mora O., Reyes Aleman J. C., Ruiz-Montiel C., Váldez-Carrasco J. and Equihua-Martínez A. New Distribution Records of the Small Avocado Seed Weevil, *Conotrachelus perseae* Barber (*Coleoptera: Curculionidae*), in Mexico and Notes on Its Biology. Coleop. Bull. 2015. 69:267–271. 2015.

[18] Vázquez A. M., Cruz-López L. and Chamé-Vázquez E. R. First Record of *Conotrachelus perseae* (*Coleoptera: Curculionidae*) in Comitán, Chiapas, Mexico. Fla. Entomol. 2015. 98:1252–1253.

[19] Salinas C. A. Biology of the small borer seed of the avocado *Conotrachelus perseae* Barber in Tacambaro, Michoacan. Especialidad en Entomología y Acarología. Instituto de Fitosanidad. Colegio de Posgraduados, Montecillo, Texcoco, Edo. de México. 1999.

[20] Abreu M. S. Penetration of the Coffee Borer *Hypothenemus hampei* (Ferrari) (Coleoptera: Scolytidae) in Coffee Fruits Different Growing Stages and Selectivity of Insecticides and Fungicides to the Entomopathogen Fungi *Beauveria bassiana.* Universidad Federal de Vicosa. 2002.

[21] Kissinger, D.G. Description of New *Copturus* Pest of Avocado from Mexico (Coleoptera: Curculionidae, Zygopinae). Acta Zool. Mex. 1957. 2:1–8.

[22] Francia R. M. Distribution of seed borers *Conotrachelus aguacate* Barber and *C. perseae* Barbe (Coleoptera: Curculionidae) in the municipalities of Tacambaro, Tocumbo, Cotija, Susupuato and Ziracuaretiro, Michoacán. Campus Montecillo, Postgrado en Fitosanidad, Entomología y Acarología, Colegio de Posgraduados, Montecillo, Texcoco, Estado de México. 2008.

[23] Gasca C. L. Trials with traps adhesive of color and monitoring of *Copturus aguacatae* Kissinger, in Ziracuaretiro, Michoacan. Instituto de Fitosanidad, Especialidad en Entomología y Acarología. Colegio de Posgraduados. 2000.

[24] Gudiño J. L. M., García A. M. Biology and habits of the branches and trunks borers of the avocado (avocado Kissinger Copturus) in the region of Uruapan, Michoacán. Facultad de Agrobiología "Presidente Juárez". Universidad Michoacana de San Nicolás de Hidalgo, Uruapan, Michoacán. 1990.

[25] Leos-Rodríguez J. A.; Kido-Cruz M. T. and Valdivia-Alcalá R. Impact of the barriers phytosanitary in the trade of avocado between Mexico and the United States of North America. Rev. Chapingo Serie Hort. 2005. 11:99–103.

[26] Peterson E. V. and Orden D. Avocado Pests and Avocado Trade. Am. J. Agric. Econ. 2008. 90:321–335.

[27] Espinosa G. N. Validation and simulation statistics of methods for the sampling of *Copturus aguacatae* Kissinger, *Conotrachelus perseae* Barber and *C. aguacatae* Barber; pests of avocado (Persea americana Mill.), in Tingüindin, Michoacan, Mexico. Departamento de Parasitología Agrícola. Universidad Autónoma Chapingo, Chapingo, México. 2007.

[28] Salas A. M. D., O'Brien C. W. and Romero-Napoles J.. Curculionoidea (Insecta: Coleoptera) from the State of Guanajuato, México. Insecta Mundi. 2001. 15:45–57.

[29] Sánchez, S. S. New records of phytophagous insects to the State of Tabasco, Mexico. Folia Entomológica Mexicana 2000. 109:113–116.

[30] Sánchez, S. S. *Conotrachelus dimidiatus* Champion (Coleoptera: Curculionidae) the weevil of the guava (*Psidium guajava* L.) in Tabasco, Mexico. Boletin del Museo de Entomología de la Universidad del Valle, Colombia. 2011. 12 (2):17–18.

[31] O'brien C. W. and Wibmer G. J. Annotated Checklist of the Weevils (Curculionidae sensu lato) of North America, Central America and the West Indies (Coleoptera: Curculionoidea). Memoirs of the American Entomological Institute. 1982. 34:1–382.

[32] Gonzalez G. E. Control of insect pests. In guava, its cultivation in Mexico. Gonzalez G. E., Padilla R. S., M. L. Reyes, C. M. Perales and V. F. Esquivel (ed.). Libro técnico 1. Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias. Campo Experimental Pabellon. Aguascalientes, México. 2002. 181 p.

[33] Tafoya F. C., Perales S. E., González G. H. G., Calyecac C. Fruit Damage.Patterns Caused by Ovipositing Females of *Conotrachelus dimidiatus* (Coleptera: Curculionidae) in Guava Trees. Psyche Res. Artic. 2010. 4 p.

[34] Maldonado J. E., Hernández L. M. F., Luna G. E., Gómez J. R. A., Flores R. J. C., Santos M. O. Bioecology of Optatus *palmaris Pascoe* (Coleoptera: Curculionidae) in Annona muricata L Southwest. Entomol. 2014. 39(4):773–781.

[35] Rubio G. J. D. External morphology of the immature stages of *Hypothenemus hampei* Ferrari (Coleoptera: Curculionidae). Rev. U. D. C. A. Actualidad y Divulgación Científica. 2009. 12 (2):157–161.

[36] Le Pelley R. H. Pests of Coffee. Longmans, Green and Co. Ltd., London. 1968. 590 p.

[37] Vega F. E. Coffee Berry Borer, *Hypothenemus hampei* (Ferrari) (Coleoptera: Curculionidae: Scolytinae). 2004. pp: 959–960.

[38] Pablo Benavides, Carmenza Góngora and Alex Bustillo (2012). IPM Program to Control Coffee Berry BorerHypothenemus hampei, with Emphasis on Highly Pathogenic Mixed Strains of Beauveria bassiana, to Overcome Insecticide Resistance in Colombia, Insecticides - Advances in Integrated Pest Management, Dr. Farzana Perveen (Ed.), ISBN: 978-953-307-780-2, InTech, Available from: http://www.intechopen.com/books/insecticides-advances-in-integrated-pest-management/ipm-program-tocontrol-coffee-berry-borer-hypothenemus-hampei-with-emphasis-on-highly-pathogenic-mix

[39] Fernandes F. L., Picanco M. C., Fernandes M. E. S., Dangelo R. A. C., Souza F. F. and Guedes R. N. C. A New and Highly Effective Sampling Plan Using Attractant-Baited Traps for the Coffe Berry Borer (*Hypothenemus hampei*). J. Pest. Sci. 2015. 88:289–299.

[40] Bustillo, P. A. E. The role of biological control in the integrated management of the seed borer of the coffee, *Hypothenemus hampei* (Ferrari) (Coleoptera: Curculionidae: Scolytinae). Rev. Acad. Colomb. Cienc. 2005. 24(110):55–68.

[41] Hernández F. L. M., Gómez J. R., Andrés A.J. Importance, pest insect and diseases fungus of the cultivation of the soursoup. Libro Técnico Núm. 1. Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias. Campo Experimental Santiago Ixcuintla, Nayarit. México. 2013. 87 p.

[42] Corrales M. G. J. Observations on the biology and behavioral food of *Optatus* sp. (Coleoptera: Curculionidae) in *Annona cherimola* Mill. In: Resúmenes de *2do*. Congreso Centroamericano y del Caribe y 3ero. Costarricense de Entomología. Editorial San José ASENCO. San José, Costa Rica, 17–21 Julio. 1995. p. 6.

[43] Hernández F. L. M., Valdez J.C., Illescas C. P. R., Maldonado E. J., Orozco M. S. Morphological description of the aedeago of *Optatus palmaris* Champion (Coleoptera: Curculionidae). Southwest. Entomol. 2012. 37:225–229.